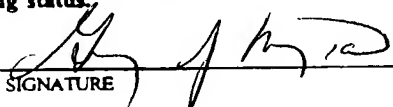


JC07 Rec'd PCT/PTO 22 FEB 2002

FORM PTO-1390 (REV. 9-2001)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER Eryurtlu - 2
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371			U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 10/069687
INTERNATIONAL APPLICATION NO. PCT/GB00/01842	INTERNATIONAL FILING DATE 05/15/2000	PRIORITY DATE CLAIMED 08/31/1999	
TITLE OF INVENTION Apparatus For Compressing And Expanding Video Data			
APPLICANT(S) FOR DO/EO/US Eryurtlu, F.M.			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information			
<p>1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.</p> <p>2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371</p> <p>3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.</p> <p>4. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31).</p> <p>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))</p> <p>a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).</p> <p>b. <input checked="" type="checkbox"/> has been communicated by the International Bureau.</p> <p>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</p> <p>6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).</p> <p>a. <input type="checkbox"/> is attached hereto.</p> <p>b. <input checked="" type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4).</p> <p>7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))</p> <p>a. <input checked="" type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).</p> <p>b. <input type="checkbox"/> have been communicated by the International Bureau.</p> <p>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</p> <p>d. <input type="checkbox"/> have not been made and will not be made.</p> <p>8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).</p> <p>9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</p> <p>10. <input type="checkbox"/> An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</p> <p>Items 11 to 20 below concern document(s) or information included:</p> <p>11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</p> <p>12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included</p> <p>13. <input checked="" type="checkbox"/> A FIRST preliminary amendment.</p> <p>14. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</p> <p>15. <input type="checkbox"/> A substitute specification.</p> <p>16. <input type="checkbox"/> A change of power of attorney and/or address letter</p> <p>17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825</p> <p>18. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4).</p> <p>19. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4)</p> <p>20. <input type="checkbox"/> Other items or information:</p>			

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I hereby certify that this <u>EE82159816US</u> is being deposited with the United States Postal Service "Express Mail Post" Office to Airmail service under <u>37 CFR 1.10</u> on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231	
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Signature of person mailing paper of fee	

U.S. APPLICATION NO. (37 CFR 1.53) 10/069687		INTERNATIONAL APPLICATION NO. PCT/GB00/01842		ATTORNEY'S DOCKET NUMBER Eryurtlu - 2	
21. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report prepared by the EPO or JPO \$1040.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY \$ 890.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$	
Total claims	14 - 20 =		x \$18.00	\$	
Independent claims	2 - 3 =		x \$84.00	\$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$280.00	\$ 890.00	
TOTAL OF ABOVE CALCULATIONS =				\$	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27 The fees indicated above are reduced by 1/2.				\$	
SUBTOTAL =				\$ 890.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$ 40.00	
TOTAL FEES ENCLOSED =				\$ 930.00	
				Amount to be refunded:	\$
				charged:	\$
a. <input type="checkbox"/> A check in the amount of \$ _____ to cover the above fees is enclosed. b. <input checked="" type="checkbox"/> Please charge my Deposit Account No. <u>12-2325</u> in the amount of \$ <u>930.00</u> to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>12-2325</u> . A duplicate copy of this sheet is enclosed. d. <input type="checkbox"/> Fees are to be charged to a credit card. WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO: Docket Administrator Lucent Technologies Inc. Room 3J-219 101 Crawfords Corner Rd. Holmdel, NJ 07733-3030			 SIGNATURE Gregory J. Murgia NAME 41209 REGISTRATION NUMBER		

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Patent Application

Inventor(s) Faruk Mehmet Eryurtlu
Case 2
Serial No. Group Art
File Date
Examiner
Title APPARATUS FOR COMPRESSING AND EXPANDING VIDEO
DATA

ASSISTANT COMMISSIONER FOR PATENTS AND TRADEMARK
WASHINGTON, DC 20231

Dear Sir:

PRELIMINARY AMENDMENT

The version of the claims showing the changes made to the claims of the application are attached for your review.

In The Claims:

Please replace claims 1, 2, 5, 8-10 and 13-14 as follows:

1. (amended) Apparatus for coding video data, comprising means for receiving pixel values organised in frames each comprising a matrix of video blocks, each video block comprising a video matrix of N pixel values, and processor means arranged:
 - a) to set each element in a prediction matrix to an initial prediction value;
 - b) in the prediction matrix, to apply a smoothing transform to the values along the rows and then along the columns, or vice versa, to obtain interpolated values;
 - c) to reset the prediction value to the interpolated value;
 - d) to calculate the difference between the reset prediction values and corresponding received pixel values to produce a residual prediction matrix containing the prediction residuals; and

e) to perform a discrete cosine transform on the prediction residuals to obtain elements of a compressed video data matrix.

2. (amended) Apparatus as claimed in claim 1, wherein the processor means is arranged iteratively to calculate the reset prediction value used to calculate the prediction residual by repeating b) and c).

5. (amended) Apparatus as claimed in claim 1, wherein a) is performed by performing a discrete cosine transform on the video matrix to obtain a transform video matrix of N coefficients, selecting n of the coefficients, setting the $N-n$ remaining coefficients to zero to obtain an initial prediction transform matrix of initial prediction coefficients, and performing an inverse discrete cosine transform on the initial prediction transform matrix to obtain a matrix of N initial prediction values.

8. (amended) Apparatus as claimed in claim 1, including means for processing pixels in a current and a previous frame to produce pixel values which are the prediction residual between the actual pixel and a motion compensated pixel.

9. (amended) Apparatus for expanding compressed video data, comprising processor means arranged:

- a) to perform an inverse discrete cosine transform on received compressed video data to obtain a prediction residual matrix;
- b) to set each element in a prediction block matrix to the initial prediction value;
- c) in the prediction matrix, to apply a smoothing transform to the values along the rows and then along the columns, or vice versa, to obtain interpolated values;
- d) to reset the prediction value to the interpolated value; and
- e) to calculate the sum of the reset prediction values and the prediction residual in corresponding positions in the received coded block matrix to produce an expanded video data matrix.

10. (amended) Apparatus as claimed in claim 9, wherein the processor means is arranged iteratively to calculate the reset prediction value used to calculate the prediction residual by repeating b) and c).

13. (amended) Apparatus as claimed in claim 9, wherein a) is performed by performing a discrete cosine transform on the video matrix to obtain a transform video matrix of N coefficients, selecting n of the coefficients, setting the $N-n$ remaining coefficients to zero to obtain an initial prediction transform matrix of initial prediction coefficients, and performing an inverse discrete cosine transform on the initial prediction transform matrix to obtain a matrix of N initial prediction values.

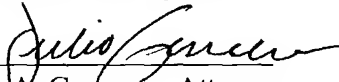
14. (amended) Apparatus as claimed in claim 13 for expanding compressed video data, wherein the processor is arranged to select $N - n$ elements from the compressed video data matrix and to set n elements to zero before performing the inverse discrete cosine transform to obtain the prediction residual matrix.

REMARKS

By way of the Preliminary Amendment, Applicant has amended the claims in the above-identified application in accordance with typical U.S. patent practice. In the event of any fees inadvertently omitted or any improper payment of fees, the Commissioner is hereby authorized to charge or credit Lucent Technologies Deposit Account No.12-2325 to correct the error now or during the pendency of this application, except for the issue fee.

If the Examiner has any questions or feels that a telephone conversation would be helpful, please contact Julio Garceran at (973) 386-2286.

Respectfully submitted,
Faruk Mehmet Eryurtlu

By: 
Julio A. Garceran, Attorney
Reg. No. 37,138

Lucent Technologies Inc.

Date: 1/3/02

VERSION OF CLAIMS SHOWING CHANGES

1. (amended) Apparatus for coding video data, comprising means for receiving pixel values organised in frames each comprising a matrix of video blocks, each video block comprising a video matrix of N pixel values, and processor means arranged [to perform the following steps]:

- a) to set each element in a prediction matrix to an initial prediction value;
- b) in the prediction matrix, to apply a smoothing transform to the values along the rows and then along the columns, or vice versa, to obtain interpolated values;
- c) to reset the prediction value to the interpolated value;
- d) to calculate the difference between the reset prediction values and corresponding received pixel values to produce a residual prediction matrix containing the prediction residuals; and
- e) to perform a discrete cosine transform on the prediction residuals to obtain elements of a compressed video data matrix.

2. (amended) Apparatus as claimed in claim 1, wherein the processor means is arranged iteratively to calculate the reset prediction value used to calculate the prediction residual by repeating [steps] b) and c).

5. (amended) Apparatus as claimed in [any preceding] claim 1, wherein [step] a) is performed by performing a discrete cosine transform on the video matrix to obtain a transform video matrix of N coefficients, selecting n of the coefficients, setting the $N-n$ remaining coefficients to zero to obtain an initial prediction transform matrix of initial prediction coefficients, and performing an inverse discrete cosine transform on the initial prediction transform matrix to obtain a matrix of N initial prediction values.

8. (amended) Apparatus as claimed in [any preceding] claim 1, including means for processing pixels in a current and a previous frame to produce pixel values

14. (amended) Apparatus as claimed in claim 13 for expanding compressed video data [compressed by apparatus as claimed in claim 7], wherein the processor is arranged to select $N - n$ elements from the compressed video data matrix and to set n elements to zero before performing the inverse discrete cosine transform to obtain the prediction residual matrix.

APPARATUS FOR COMPRESSING AND EXPANDING VIDEO DATA

This invention relates to apparatus for compressing and expanding video data.

Existing video compression standards are all based on block discrete cosine
5 transform (DCT) transform. The picture is divided into square blocks consisting of 8x8
pixels. The blocks may contain the actual pixels or the prediction residual, which is the
difference between the actual and motion compensated block pixels. Each block is
transformed into DCT domain, which results in 8x8 coefficients.

The DCT process is used to remove the spatial redundancy between the pixels in
10 the same block. However, it does not consider the redundancy between the pixels from
different blocks. The first versions of the standards did not use any technique to exploit
the correlation between different blocks. Recently, MPEG-4 and H.263+ have added
tools/options to exploit this redundancy to certain extent. At present, MPEG-4 predicts
the DC coefficient (first coefficient, which is actually the block average) of the current
15 block by using the DC coefficients of the neighbouring blocks. H.263+ does this, and in
addition, it also predicts the first row or column of the DCT coefficients in some cases if
there is any benefit.

In brief, existing compression algorithms exploit the fact that the DCT coefficients
in the neighbouring blocks are sometimes similar to those in the current block. This
20 means that if the blocks contain completely different coefficients, the prediction will not
work.

- a) to set each element in a prediction matrix to an initial prediction value;
- b) in the prediction matrix, to apply a smoothing transform to the values along rows and then along columns, or vice versa, to obtain interpolated values;
- c) to set the prediction values to the interpolated values;
- d) to calculate the differences between the prediction values and corresponding received pixel values to produce a residual prediction matrix containing prediction residuals.

e) . to perform a discrete cosine transform on the prediction residuals to
20 obtain elements of a compressed video data matrix, wherein the processor means is
arranged iteratively to calculate the prediction values used to calculate the prediction
residuals by repeating steps b) and c).

- 2a -

The number of iterations may be predetermined or, in an alternative, the iterations may be repeated until the change in the prediction value between one iteration and the next, is less than a predetermined threshold.

Step a) is most preferably performed by performing a discrete cosine transform on the video matrix to obtain a transform video matrix of N coefficients, selecting n of the coefficients, setting the $N-n$ remaining coefficients to zero to obtain an initial prediction transform matrix of initial prediction coefficients, and performing an inverse discrete cosine transform on the initial prediction transform matrix to obtain a matrix of N initial prediction values.

In that case, the processor is preferably arranged to set n of the elements in the compressed video data matrix equal to the n coefficients selected from the transform video matrix, and to select the remaining $N-n$ coefficients from the prediction residuals.

The processor is further preferably arranged to adjust the prediction residuals before selecting the remaining $N - n$ elements, by:

- f) performing a discrete cosine transform on the reset prediction value matrix to obtain a prediction transform matrix,
- g) selecting n coefficients from the transform prediction matrix,

- g) selecting n coefficients from the transform prediction matrix,
- h) subtracting the selected n transform prediction matrix coefficients from the selected n transform video coefficients to obtain n residual coefficients;
- i) setting n elements of an adjustment transform matrix to the values of the
5 n residual coefficients and setting $N - n$ remaining elements to zero;
- j) performing an inverse discrete cosine transform on the adjustment transform matrix to obtain an adjustment value matrix; and
- k) subtracting the adjustment value matrix from the reset prediction value matrix.

10 The apparatus may include means for processing pixels in a current and a previous frame to produce pixel values which are the prediction residual between the actual pixel and a motion compensated pixel.

The invention extends to apparatus for expanding video data compressed by apparatus as claimed in any preceding claim, comprising means for receiving the
15 compressed video matrix, and processor means arranged to perform the following steps:

- a) to perform an inverse discrete cosine transform on received compressed video data to obtain a prediction residual matrix;
- b) to set each element in a prediction matrix to the initial prediction value;
- c) in the prediction matrix, to apply a smoothing transform to the values
20 along the rows and then along the columns, or vice versa, to obtain interpolated values;
- d) to reset the prediction value to the interpolated value; and
- e) to calculate the sum of the reset prediction values and the prediction residual in corresponding positions in the received coded block matrix to produce an expanded video data matrix.

25 Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figures 1A and 1B, when assembled as shown in Figure 1, show a block diagram of a transmitter including apparatus for compressing video data embodying the invention; and

Figures 2A and 2B, when assembled as shown in Figure 2, show a block diagram of a receiver including apparatus for expanding the video data compressed by the apparatus of Figure 1.

A frame of quantised and digitised pixel values is divided into video matrices comprising blocks of N pixels where as an example $N = 8 \times 8$. With a switches 1a, 1b set to "intra" as illustrated, a video matrix 2 is discrete cosine transformed in step 4 to produce a video transform matrix 6 comprising a block of N discrete cosine transform (DCT) coefficients where in the example $N = 8 \times 8$. Of these a square of n coefficients are selected in step 8, essentially the DC coefficient and optionally other coefficients.

In step 10, the remaining $N - n$ (i.e. $8 \times 8 - n$) coefficients are set to zero to obtain an initial prediction transform matrix 12. The coefficients are inverse discrete cosine transformed in step 14 to obtain an initial prediction matrix 16.

In step 18 interpolation is performed between the initial prediction values of matrix 16 and the values in the neighbouring preceding blocks to reset the prediction matrix. Values in a row 20, spatially nearest to the video matrix 2, are used in the interpolation process. Linear interpolation is performed between the value in a row/column position in the initial prediction matrix and the value in a corresponding column in row 20 weighted according to the distance in rows from the row 20.

Similarly values in a column 22, spatially nearest the video matrix 2, are used in the interpolation process. Linear interpolation is also performed between the value in a row/column position in the initial prediction matrix and the value in a corresponding row in column 22, weighted by the distance in columns from the column 22.

$$V_{\text{interpolated}} = \{2V_{r,c} + V_{20,c}/r + V_{r,22}/c\}^{1/4}$$

Where,

$V_{\text{interpolated}}$ is the interpolated prediction value, $V_{r,c}$ is the value at row r column c of the initial prediction matrix 16, $V_{20,c}$ is the value in column c of row 20, r is the distance in rows of the position r, C from row 20, $V_{r,22}$ is the value at row r in column 22, and C is the distance in columns of the position r, C from the column 22.

The interpolation step 18 is performed iteratively until, in one example, the change in values in one step is less than a predetermined threshold. In another example, a predetermined fixed number of iterations is performed.

When the iterations are complete, the reset prediction values are discrete cosine transformed in step 24 to obtain 8×8 coefficients of a transform prediction matrix 26. In step 28 n coefficients are selected and, in step 30 subtracted from the n video transform coefficients previously selected in step 8 to produce n residual coefficients. In step 32 the remaining $8 \times 8 - n$ coefficients are set to zero to obtain 8×8 adjustment coefficients 34. These are inverse discrete cosine transformed to produce 8×8 adjustment values.

The values of the reset prediction matrix are adjusted by subtracting from them the adjustment values. The values in the video matrix are subtracted from the adjusted reset prediction values to obtain a prediction residual matrix 34 of 8×8 values. In step 36, the prediction residual values are discrete cosine transformed to produce a transform residual matrix having 8×8 coefficients. Of these n will be zero because of the adjustment made to the reset prediction matrix.

The remaining $8 \times 8 - n$ coefficients are selected in step 38 and assembled with the n video transform coefficients previously selected in step 8 to provide a compressed

video matrix of 8×8 coefficients. These are channel coded in step 40 and transmitted through a medium 42.

In the apparatus shown in Figures 2A and 2B, the signal received from the medium 42 is channel decoded in step 44 to produce a decoded compressed video data matrix 46 of 8×8 coefficients. Of these, n are selected in step 48 and the remaining $8 \times 8 - n$ are set to zero in step 50 to obtain a decoded initial prediction transform matrix 52 having 8×8 coefficients. The coefficients are inverse discrete cosine transformed to produce a +

decoded initial prediction matrix 54 having 8×8 initial prediction values.

10 In step 56, interpolation is performed iteratively on the initial prediction matrix in exactly the same manner as was performed in step 18 on the prediction matrix 16 using the (decoded) neighbouring row 20 and column 22 to obtain a matrix 58 of reset prediction values.

In step 60, the remaining $8 \times 8 - n$ coefficients of matrix 46 are selected and n coefficients are set to zero in step 62 to obtain a decoded transform residual matrix 64 having 8×8 coefficients. These coefficients are inverse discrete cosine transformed in step 66 to obtain a decoded prediction residual matrix having 8×8 residual values. In step 68 these are added to the reset prediction values in matrix 58 to produce a decoded video matrix 70 containing 8×8 pixel values corresponding to those of matrix 2.

20 Putting the switches 1a, 1b in their "inter" position, rearranges the apparatus to operate not on the current frame video matrix, but on the residual produced by subtracting the values in a motion compensated block of a previous frame, from the values in the current frame video matrix 2 in step 74. The motion compensated values

are added back in step 76 to produce the initial prediction matrix 16 values, and subtracted in step 78 from the reset prediction values.

In the expander shown in Figure 2, motion compensated values obtained in a decoded motion compensated video matrix 80 from a previously decoded frame, are
5 added back in step 82 to produce the initial prediction matrix.

Claims

1. Apparatus for coding video data, comprising means for receiving pixel values organised in frames each comprising a matrix of video blocks, each video block comprising a video matrix of N pixel values, and processor means arranged to
5 perform the following steps:
 - a) to set each element in a prediction matrix to an initial prediction value;
 - b) in the prediction matrix, to apply a smoothing transform to the values along rows and then along columns, or vice versa, to obtain interpolated values;
 - 10 c) to set the prediction values to the interpolated values;
 - d) to calculate the differences between the prediction values and corresponding received pixel values to produce a residual prediction matrix containing prediction residuals; and characterised in that the processor means is also arranged
 - e) to perform a discrete cosine transform on the prediction residuals to
15 obtain elements of a compressed video data matrix wherein the processor means is arranged iteratively to calculate the prediction values used to calculate the prediction residuals by repeating steps b) and c).
2. Apparatus as claimed in claim 1, wherein the number of iterations is predetermined.
- 20 3. Apparatus as claimed in claim 1, wherein the processor means is arranged to repeat the iterations until the change in the prediction value between one iteration and the next, is less than a predetermined threshold.
4. Apparatus as claimed in any preceding claim, wherein step a) is performed by performing a discrete cosine transform on the video matrix to obtain a
25 transform video matrix of N coefficients, selecting n of the coefficients, setting the N- n remaining coefficients to zero to obtain an initial prediction transform matrix of initial prediction coefficients, and performing an inverse discrete cosine transform on the initial prediction transform matrix to obtain a matrix of N initial prediction values.

5. Apparatus as claimed in claim 4 wherein the processor is arranged to set n of the elements in the compressed video data matrix equal to the n coefficients

5 selected from the transform video matrix, and to select the remaining $N-n$ coefficients from the prediction residuals.

6. Apparatus as claimed in claim 5 wherein the processor is arranged to adjust the prediction residuals before selecting the remaining $N - n$ elements, by:

- f) performing a discrete cosine transform on the reset prediction value
- 10 matrix to obtain a prediction transform matrix,
- g) selecting n coefficients from the transform prediction matrix,
- h) subtracting the selected n transform prediction matrix coefficients from the selected n transform video coefficients to obtain n residual coefficients;
- i) setting n elements of an adjustment transform matrix to the values of the
- 15 n residual coefficients and setting $N - n$ remaining elements to zero;
- j) performing an inverse discrete cosine transform on the adjustment transform matrix to obtain an adjustment value matrix; and
- k) subtracting the adjustment value matrix from the reset prediction value matrix.

20 7. Apparatus as claimed in any preceding claim, including means for processing pixels in a current and a previous frame to produce pixel values which are the prediction residual between the actual pixel and a motion compensated pixel.

8. Apparatus for expanding video data compressed by apparatus as claimed in any preceding claim, comprising means for receiving the compressed video matrix,

25 and processor means arranged to perform the following steps:

- a) to perform an inverse discrete cosine transform on received compressed video data to obtain a prediction residual matrix;

c) in the prediction matrix, to apply a smoothing transform to the values along rows and then along columns, or vice versa, to obtain interpolated values;

10 9. Apparatus as claimed in claim 8, wherein the processor means is arranged iteratively to calculate the prediction values used to calculate the prediction residuals by repeating steps b) and c).

15 11. Apparatus as claimed in claim 9, wherein the processor means is arranged to repeat the iterations until the change in the prediction value between one iteration and the next, is less than a predetermined threshold.

13. Apparatus as claimed in claim 12 for expanding video data
25 compressed by apparatus as claimed in claim 7, wherein the processor is arranged to
select $N-n$ elements from the compressed video data matrix and to set n elements to zero
before performing the inverse discrete cosine transform to obtain the prediction residual
matrix.

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
8 March 2001 (08.03.2001)

PCT

(10) International Publication Number
WO 01/17266 A1

(51) International Patent Classification⁷: H04N 7/26, 7/30

Mehmet [TR/GB]; 6 Greensand Close, Swindon, Wiltshire
SN2 3FW (GB).

(21) International Application Number: PCT/GB00/01842

(22) International Filing Date: 15 May 2000 (15.05.2000)

(74) Agents: WILLIAMS, David, J. et al.; Lucent Technologies UK Limited, 5 Mornington Road, Woodford Green, Essex IG8 OTU (GB).

(25) Filing Language: English

(81) Designated States (*national*): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(26) Publication Language: English

(30) Priority Data: 99306931.9 31 August 1999 (31.08.1999) EP

(71) Applicant (for all designated States except US): LU-CENT TECHNOLOGIES INC. [US/US]; 600 Mountain Avenue, Murray Hill, NJ 07974-0636 (US).

Published:

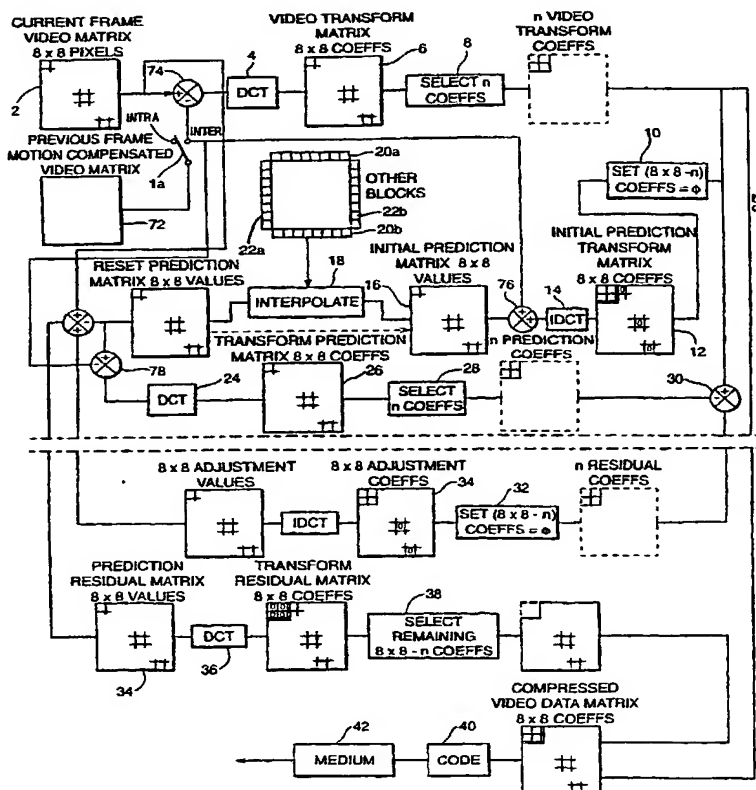
— With international search report.

(72) Inventor; and

(75) Inventor/Applicant (for US only): ERYURTLE, Faruk,

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND APPARATUS FOR MACROBLOCK DC AND AC COEFFICIENT PREDICTION FOR VIDEO CODING



(57) Abstract: Existing video data compression algorithms exploit the fact that the DCT coefficients in the neighbouring blocks are sometimes similar to those in the current block. This means that if the blocks contain completely different coefficients, the prediction will not work. Apparatus for coding video data is disclosed in which element in a prediction matrix is set to an initial prediction value. In the prediction matrix, a smoothing transform is applied to the values along the rows and then along the columns, or vice versa, to obtain interpolated values. The prediction value is reset to the interpolated value and the difference between the reset prediction values and corresponding received pixel values is calculated to produce a residual prediction matrix containing the prediction residuals. A discrete cosine transform is performed on the prediction residuals to obtain elements of a compressed video data matrix. The processor means is preferably arranged iteratively to calculate the reset prediction value used to calculate the prediction residual by repeating steps b) and c).

WO 01/17266 A1

FIG. 1

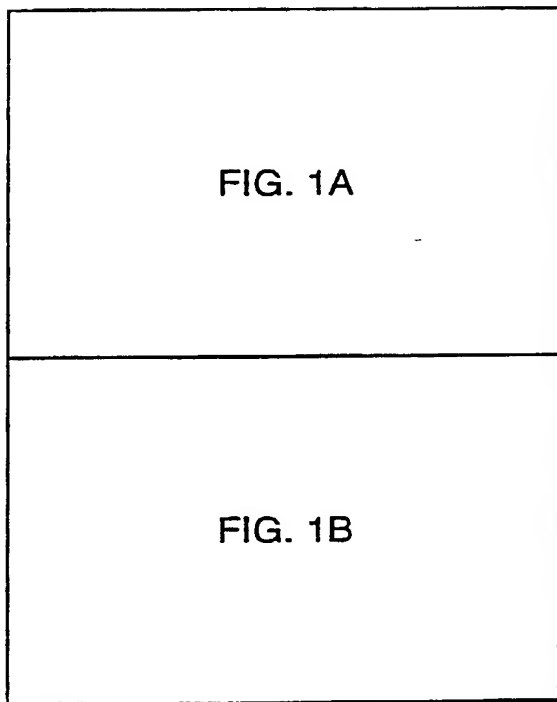


FIG. 2

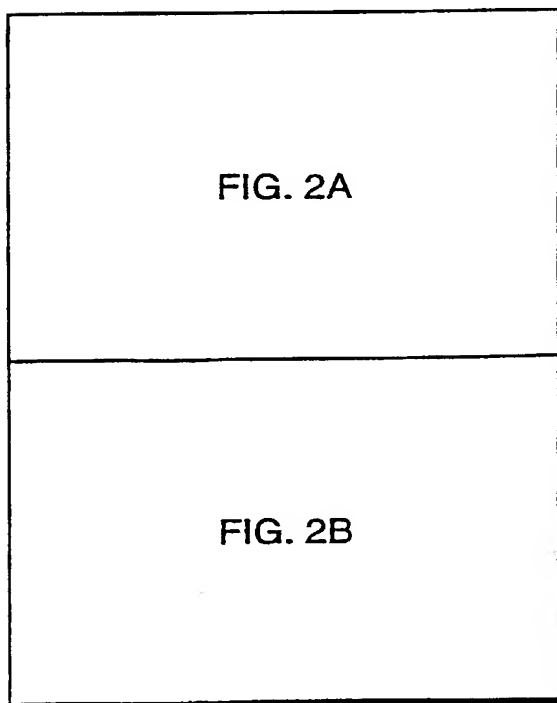
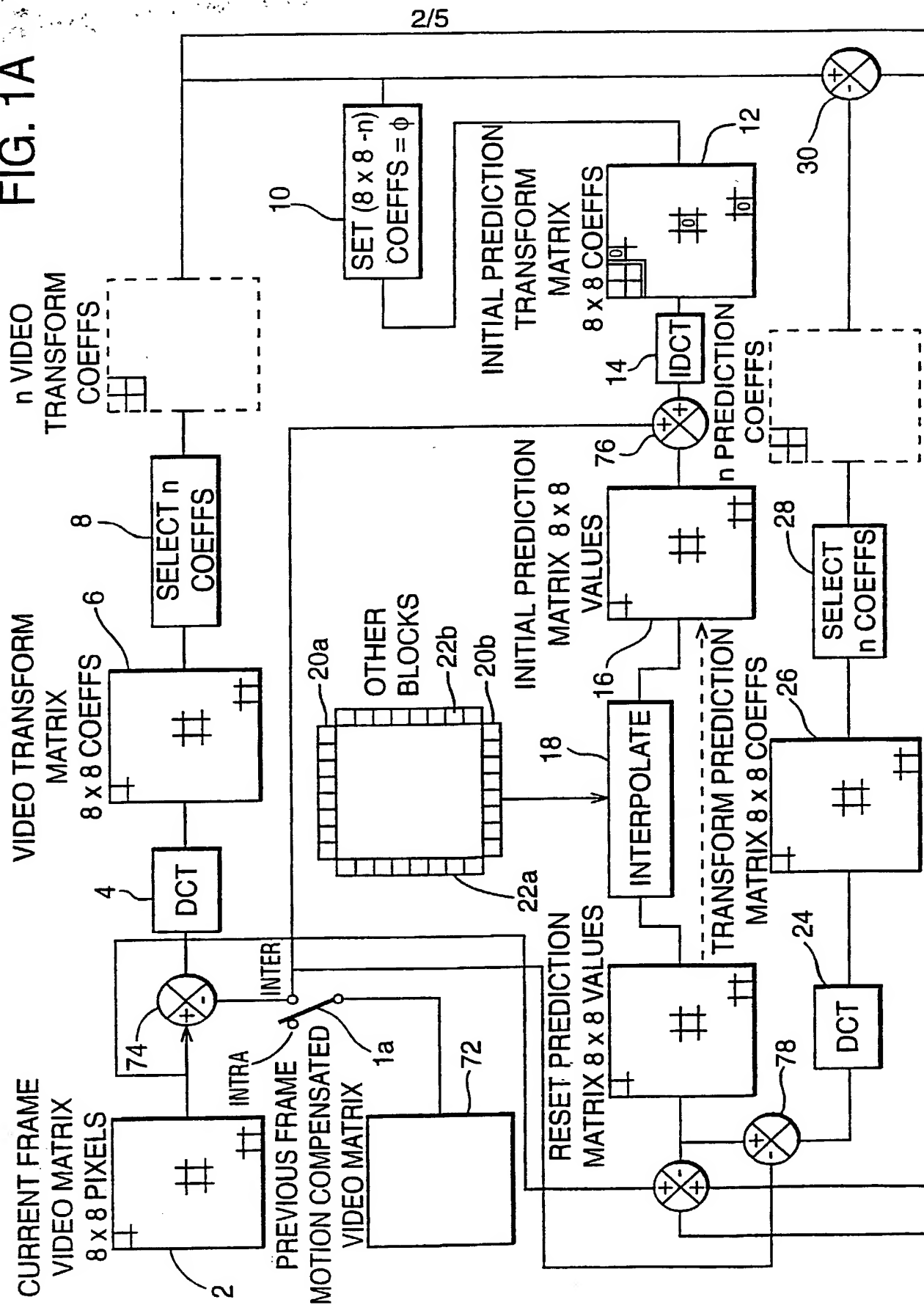


FIG. 1A



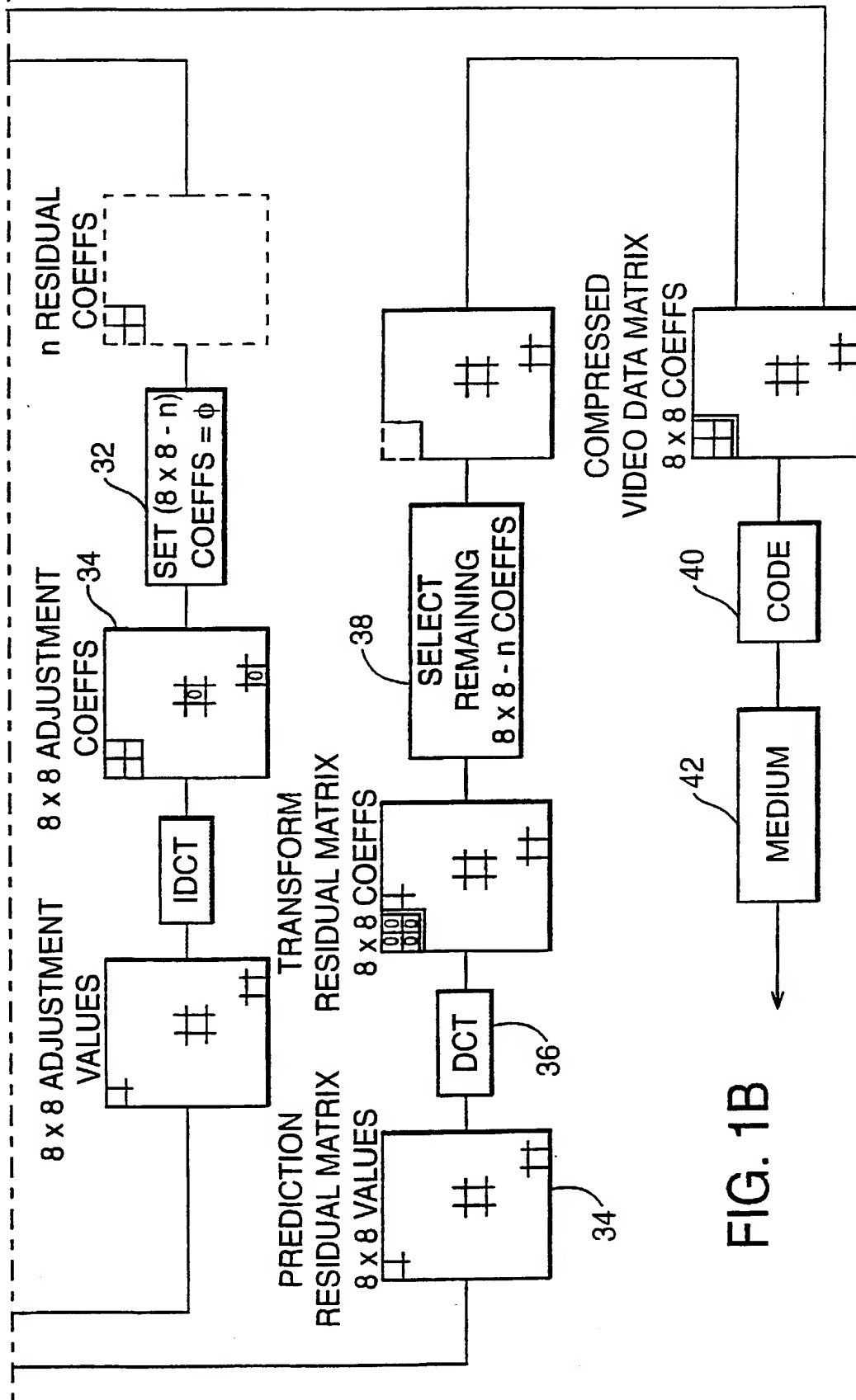
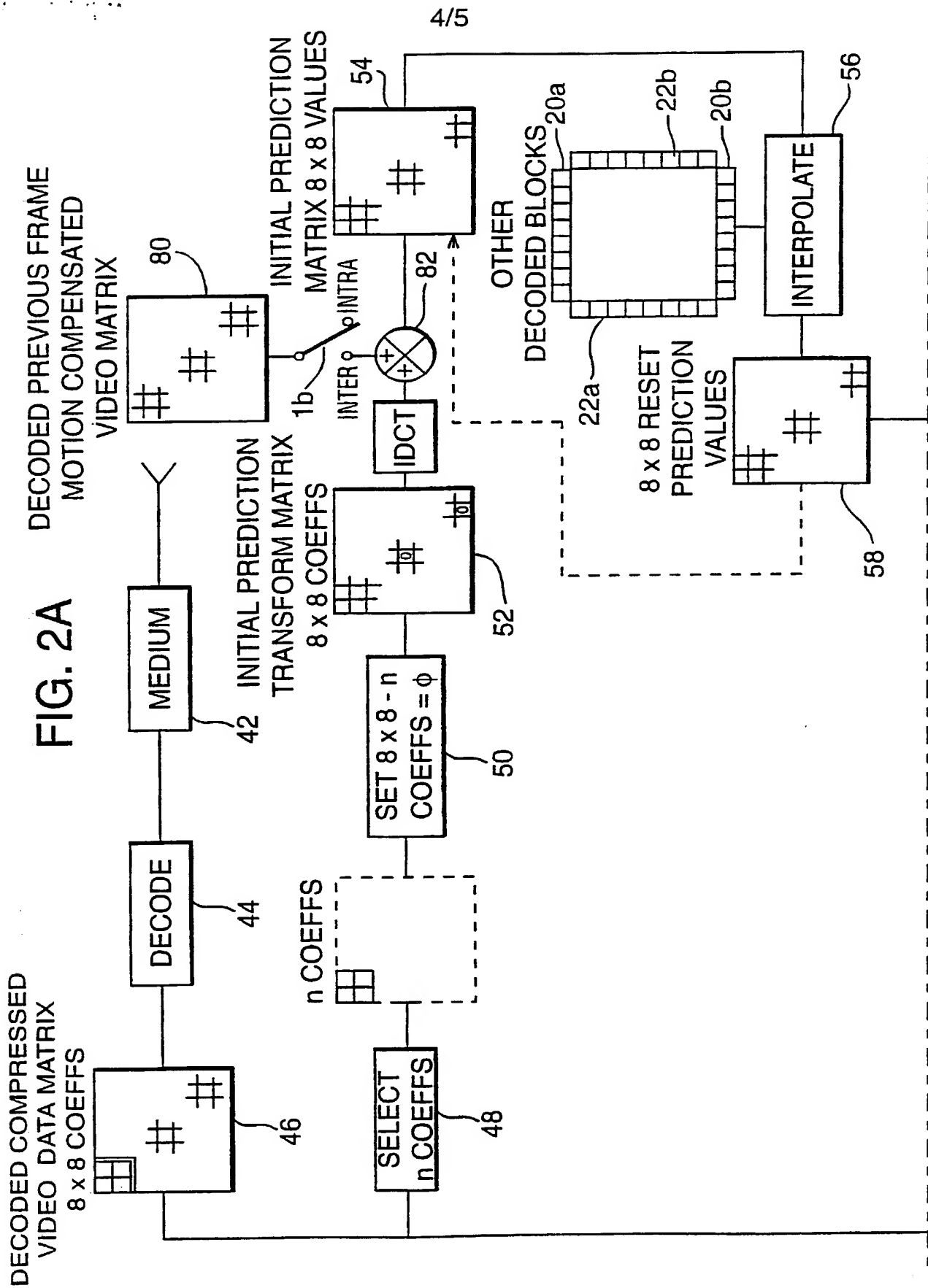


FIG. 1B

DECODED PREVIOUS FRAME
MOTION COMPENSATED



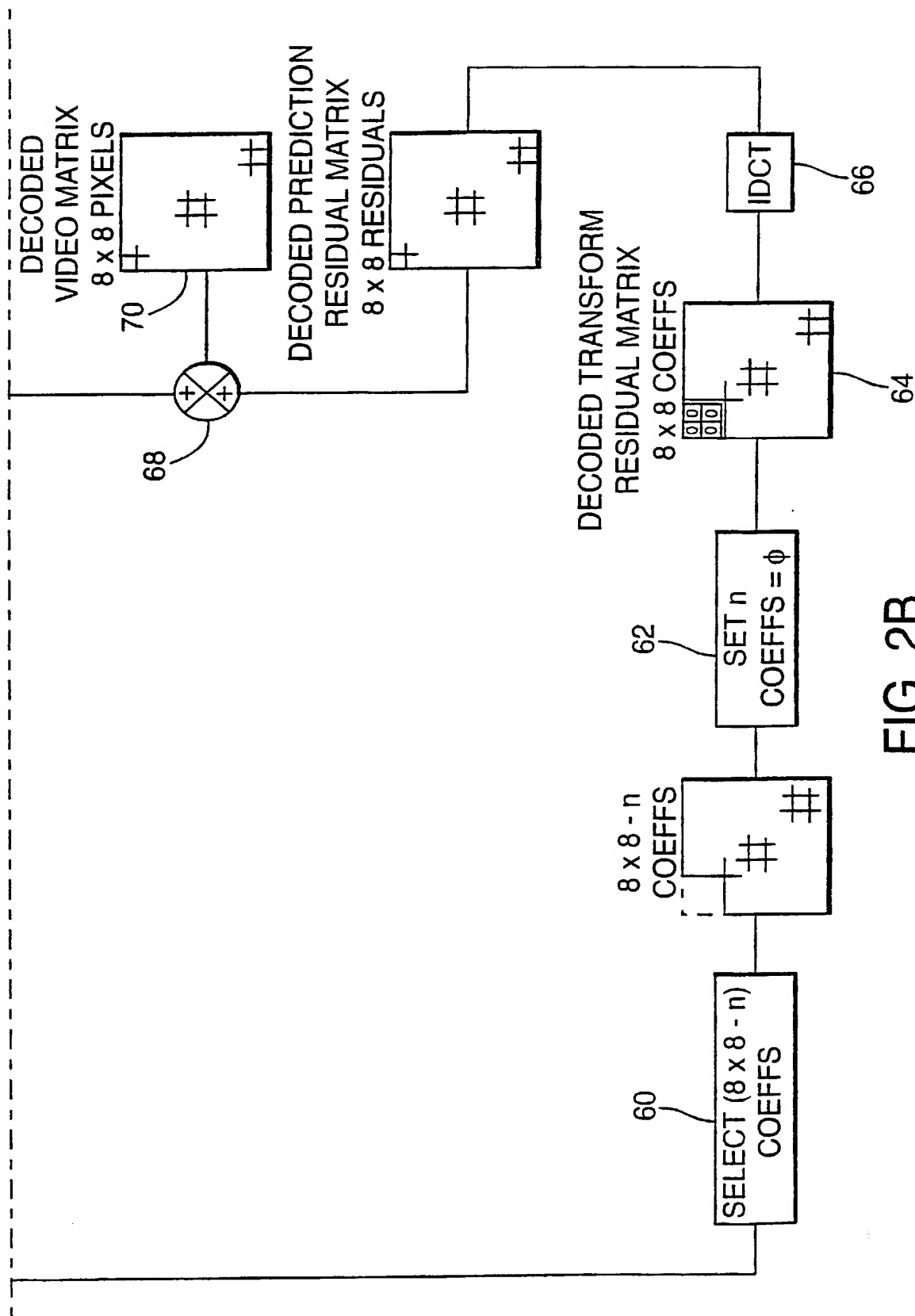


FIG. 2B

F.M. Eryurtlu 2

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Declaration and Power of Attorney

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **Method And Apparatus For Macroblock DC And AC Coefficient Prediction for Video Coding** the specification of which

☒ is attached hereto

OR

☐ was filed on _____ and granted Application Serial Number _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to in this oath or declaration.

I acknowledge the duty to disclose all information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

European Application No. 99306931.9 filed August 31, 1999

I hereby claim the benefit under Title 35, United States Code, 120 of any foreign application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

**International
Patent Application No.
PCT/GB00/01842**

**Filing Date
15th May 2000**

**Status
Pending**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States

Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorney(s) with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith:

Kenneth M. Brown	(Reg. No. <u>37590</u>)
Donald P. Dinella	(Reg. No. <u>39961</u>)
Martin I. Finston	(Reg. No. <u>31613</u>)
Barry H. Freedman	(Reg. No. <u>26166</u>)
Julio A. Garceran	(Reg. No. <u>37138</u>)
Jimmy Goo	(Reg. No. <u>36528</u>)
Stephen M. Gurey	(Reg. No. <u>27336</u>)
John M. Harman	(Reg. No. <u>38173</u>)
Matthew J. Hodulik	(Reg. No. <u>36164</u>)
Michael B. Johannesen	(Reg. No. <u>35557</u>)
Irena Lager	(Reg. No. <u>39260</u>)
John B. MacIntyre	(Reg. No. <u>41170</u>)
Christopher N. Malvone	(Reg. No. <u>34866</u>)
John F. McCabe	(Reg. No. <u>42854</u>)
Michael A. Morra	(Reg. No. <u>28975</u>)
Gregory J. Murgia	(Reg. No. <u>41209</u>)
Claude R. Narcisse	(Reg. No. <u>38979</u>)
Neil R. Ormos	(Reg. No. <u>35309</u>)
Gregory C. Ranieri	(Reg. No. <u>29695</u>)
Eugene J. Rosenthal	(Reg. No. <u>36658</u>)
Ronald D. Slusky	(Reg. No. <u>26585</u>)
Ozer M.N. Teitelbaum	(Reg. No. <u>36698</u>)
Charles L. Warren	(Reg. No. <u>27407</u>)

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I hereby authorize these attorneys to insert in the above blanks the filing date and application serial no. when known.

Please address all correspondence to the Docket Administrator (Rm. 3J-219), Lucent Technologies Inc., 101 Crawfords Corner Road, Holmdel, New Jersey 07733-3030. Telephone calls should be made to Christopher Buckley by dialing 011-44-208-504-2824.

Full name of sole inventor: Faruk Mehmet Omer Eryurtlu

Inventor's signature *F. Eryurtlu* Date 3rd September 2001

Residence: Swindon, Wiltshire, Great Britain

Citizenship: Turkey

Post Office Address: 21 Gamekeepers Close
Swindon
Wiltshire SN2 3ZQ
Great Britain